United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
9014 East 21st Street
Tulsa, Oklahoma 74129
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/
2010-F-0111

April 20, 2010

TITLE	SURNAME	DATE
Project Biologist	[illegible]	4-20
Admin Assistant	M. White	4-20
Admin Officer	J Deaton	4-20
Deputy Project Leader		
Project Leader		

John Mehlhoff
Bureau of Land Management
Oklahoma Field Office
7906 East 33rd Street, Suite 101
Tulsa, Oklahoma 74145-1352

Dear Mr. Mehlhoff:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) of potential impacts to listed species from the Bureau of Land Management's (BLM) issuance of drilling permits to Chizum Oil, LLC.'s for Lizzie Starr #1-18 and #2-18 extraction wells of federal trust minerals in Creek County, Oklahoma. BLM reference numbers NM-040-2010-001 and 002.

This BO has been prepared in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) and 50 Code of Federal Regulations [CFR] §402 of our interagency regulations governing section 7 of the ESA. Consultation began on February 2, 2010, the date a complete formal consultation package was received.

This BO is primarily based on information provided in the BLM's January 4, 2010, biological assessment (which was received on February 2, 2010). Additional information was obtained through telephone conversations, electronic mail, and meetings between the Service and BLM. A complete administrative record of this consultation is on file at the Oklahoma Ecological Services Field Office (OESFO).

Consultation History

On February 2, 2010, the Service received a memorandum from BLM requesting formal consultation for Chizum Oil, LLC.'s Lizzie Starr #1-18 and #2-18 extraction wells of federal trust minerals in Creek County, Oklahoma.

On March 2, 2010, the Service and BLM met to discuss this formal consultation request. The Service verbally notified BLM that the Chizum Oil, LLC.'s Lizzie Starr #1-18 and #2-18 consultation packages were complete and the Service would start developing a BO.

The Service appreciates the cooperation extended by the BLM during this consultation. If further assistance or information is required, please contact Hayley Dikeman or me at the above address or telephone (918) 581-7458.

Sincerely,

Kenneth D. Frazier
Assistant Field Supervisor

cc: Regional Director, FWS, Albuquerque, NM
HD/jd:2010-F-0111 BO BLM Chizum Oil Lizzie Starr 3-24-10 final

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BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

PROJECT LOCATION

The project is located near Depew in Creek County Oklahoma. The legal description is sec. 18, T. 15 N., R. 8 E., of the Indian Meridian.

SITE DESCRIPTION

The project is located within the Northern Cross Timbers ecoregions. The project area is characterized by native grass species such as little bluestem *Schizachyrium scoparium*, indiangrass *Sorghastrum nutans*, prairie threeawn *Aristida oliantha,* and Scribner's panicum *Panicum oligosanthes*. Dominant tree species found at the project area include post oak *Quercus stellata,* blackjack oak *Q. marilandica,* and eastern red cedar *Juniperus virginiana*. Soils are Stephenville-Darnell complex, 3 to 5 percent slopes. No drainages or wetlands were observed within 300 feet during the on-site visit. The Service's National Wetlands Inventory Depew quad map showed a Palustrine Open Water Permanently Flooded Diked/Impounded (POWHh) wetland within 300 feet of the Lizzie Starr #1-18 pad, however, the actual distance is over 450 feet away (Appendix 1).

The current land uses are primarily rangeland and secondarily as woodland. Cattle are pastured on and around the sites. An extensive oil field complex surrounds the sites. Small impoundments are common.

PROJECT DESCRIPTION

Chizum Oil LLC proposes to drill two separate oil wells in sec. 18, T. 15 N., R. 8 E., Creek County, Oklahoma (Appendix 2). Each well pad is 200 by 200 feet with a 50 by 100 foot pad storage area (1.03 acre). The access road for the Lizzie Starr #1-18 is 620 feet long by 16 feet wide (0.23 acre), for a total disturbance area of 1.26 acre. The access road for the Lizzie Starr #2-18 is 411 feet long by 16 feet wide (0.15 acre), for a total disturbance area of 1.18 acres. The two well pads are located 1,100 feet apart (Appendix 2). The combined disturbance area is 2.44 acres.

CONSERVATION MEASURES

The Service's standard protection recommendations and priority conservation measures regarding the ABB previously included:

1. conducting surveys for the ABB, and implementing trap and relocation or baiting away measures to avoid impacts to the ABB; or

2. in lieu of surveys, assume that the ABB is present, and implement the trap and relocation measures.

Our recommendation to conduct surveys for ABBs was based on the life history requirements of the ABB and the lack of specific or current survey data in a given area. In areas where survey data was available and current, we could safely assume that ABBs were present and implementation of avoidance measures could proceed without first conducting a survey.

Since the ABB was listed, survey data in Oklahoma has increased dramatically, especially in the last 5 years. Now that such presence/absence baseline information has been attained, the Service is focusing on other conservation actions identified in the ABB Recovery Plan. Specifically, we are focusing on habitat loss, degradation, and fragmentation, which are believed to be the primary limiting factors for ABBs (USFWS 1991). Consequently, the Service has identified priority areas for ABB habitat conservation in Oklahoma, identified priority recovery research needs for the ABB, and established an agreement with the Oklahoma Chapter of The Nature Conservancy (TNC) regarding a conservation fund for the ABB. The priority areas identified by the Service are large tracts of land currently held in perpetuity for fish and wildlife conservation, and where the ABB is known to occur. One of the Service's primary conservation goals for the ABB is to facilitate expansion of these existing areas to increase quality habitat for the ABB over the long-term. Together, TNC and the Service utilize the ABB Conservation Fund for the conservation of the ABB. The ABB Conservation fund is held by TNC. A Memorandum Of Agreement (MOA) between the Service and TNC stipulate the management and responsibilities of the ABB Conservation Fund.

The Service believes that due to the ABB's life history requirements, the proposed timing of project construction, and the size of the project, all of the available standard protection recommendations fail to completely avoid take. Consequently, the Service recommended formal consultation and the federal action agency is proposing a donation to the ABB Conservation Fund. This will provide long-term conservation for the ABB. The contribution amount will be equivalent to the cost of conducting ABB presence/absence surveys and subsequent baiting away or trapping and relocation for this project. Funds in the ABB Conservation Fund would be expended on ABB research, land acquisition, conservation easements, or any other conservation measure determined by the Service to result in a net conservation benefit to the ABB. The Service has explained that habitat conservation does not mitigate for impacts to the ABB, because the ESA does not allow for the mitigation of impacts to federally listed species. However, habitat conservation does provide for long-term conservation for the ABB by expanding the quantity of important habitat areas. This conservation measure also allows the federal action agency to fulfill their Section 7(a)(1) responsibility which stipulates that federal agencies shall utilize their authorities in furtherance of the ESA.

To minimize impacts to ABBs the federal action agency proposes the following:

1. An ABB conservation fund contribution will be made for the site. Instructions will be provided by the Service and BLM regarding the contribution of these funds.

2. Ground clearing and grading associated with access road and pad construction will be done with the minimum allowable soil disturbance.

3. Wildlife Resource General Conditions of Approval (WRGCOAs) included in the BLM General Requirements attached to the approved Application for Permit to Drill and use of standard Best Management Practices should provide extra measures of protection to general wildlife populations and habitats in the area. Impacts to the wildlife resource component of the environment can be avoided or minimized by adopting the WRGCOAs and Best Management Practices. WRGCOA #4 (Burying Transmission Lines) and Notice to Lessees (NTL) 96-01-TDO (Modification of Oil and Gas Facilities to Minimize Bird and Bat Mortality) address measures designed to protect migratory birds from accidental deaths associated with power line collisions/electrocutions, open-vent exhaust stacks and open pits and tanks.

STATUS OF THE SPECIES

The BLM reviewed the Service's federally-listed endangered, threatened, proposed, and candidate species for Creek County, Oklahoma. This list consists of the ABB, interior least tern *Sterna antillarium*, and piping plover *Charadrius melodus*. The BLM has determined that the interior least tern and the piping plover may possibly pass over the area during migration, but it is highly unlikely that either of these wells would pose any direct, indirect, interdependent, interrelated, or cumulative effect on the interior least tern or the piping plover. Consequently, BLM has made a determination of "no effect" to these species from the proposed action.

Based upon the soils and habitat associated with the project location, there is potential for the ABB to occur in the proposed project location. Creek County is within the historic ABB range, although no positive survey data exists for the county (Appendix 3). The nearest positive survey is in Okfuskee County, 10 miles to the south, and was recorded in 2003. The BLM's biological analysis resulted in a "May Affect-Likely to Adversely Affect" biological determination based on the timeframe for drilling the two wells and having performed no presence/absence survey or pre-inactive season bait-away in the project area.

STATUS AND DISTRIBUTION

Distribution

Historically the geographic range of the ABB encompassed over 150 counties in 35 states, covering most of temperate eastern North America and the southern borders of three eastern Canadian provinces (Appendix 4, Service 1991; Peck and Kalbars 1987). Historic records from Texas (single record c. 1935) in the south, north to Montana (single record in 1913) and the southern fringes of Ontario, Quebec, and as far east as Nova Scotia and Florida are known (Appendix 4). Documentation is not uniform throughout this broad historical range. More records exist from the Midwest into Canada and in the northeastern United States than from the southern Atlantic and Gulf of Mexico region (Service 1991). During the 20th century, the ABB disappeared from over 90 percent of its historical range (Ratcliffe 1995). The last ABB specimens along the mainland of the Atlantic seaboard, from New England to Florida, were collected in the 1940's (Service 1991). At the time of listing, known populations were limited to one on Block Island, Rhode Island, and one in Latimer County, Oklahoma. In 1991 when the Recovery Plan was completed, Creighton et al.

(1993) reported the discovery of a previously unknown population on Cherokee Wildlife Management area, adjacent to Camp Gruber in Muskogee and Cherokee counties, Oklahoma. They also reported the re-discovery of a single ABB specimen on private land in Sequoyah County.

Currently, the ABB is known to occur in only eight states: on Block Island off the coast of Rhode Island, Nantucket Island off the coast of Massachusetts, eastern Oklahoma (Appendix 4), western Arkansas (Carlton and Rothwein 1998), Loess Hills in south-central and Sand Hills in north-central Nebraska (Ratcliffe 1996, Bedick et al. 1999), Chautauqua Hills region of southeastern Kansas (Sikes and Raithel 2002), south central South Dakota (Backlund and Marrone 1995, 1997; Ratcliffe 1996), and northeast Texas (Godwin 2003, Appendix 4). Most existing populations are located on private land. Populations known to exist on public land include: Ouachita National Forest, Arkansas / Oklahoma; Ozark-St. Francis National Forests, Arkansas; Camp Gruber, Oklahoma; Fort Chaffee, Arkansas; Sequoyah National Wildlife Refuge, Oklahoma; Block Island National Wildlife Refuge, Rhode Island; Valentine National Wildlife Refuge, Nebraska; and Camp Maxey, Texas.

Status

Lomolino and Creighton (1996) found at Camp Gruber that in comparison to the ABB, *N. orbicollis*, *N. tomentosus*, and *N. marginatus* were nearly 20, five, and two times as abundant, respectively. Kozol (1989) demonstrated that *N. orbicollis* was about eight times more abundant than ABBs on Block Island, Rhode Island while Walker (1957) collected 19 times more *N. orbicollis* (175) than ABBs (9) in the single trapping array where the latter species was encountered in Tennessee.

Population Estimate

Most standard techniques used to estimate population size assume that marked and unmarked individuals are equally likely to be captured, and that a substantial number of the animals remain in the trappable population from one trapping period to the next. The high turnover of trappable individuals observed in ABBs strongly suggest that the latter portion of this overall assumption is not valid for ABBs, and that conventional methods of estimating population numbers may not be applicable. This may be less of a problem for the insular population on Block Island, Rhode Island where, because of the relatively small size of the island [6459 miles (2,614 ha)], a significant proportion of the population can be monitored. Elsewhere, however, accurate estimates of absolute or even relative densities remain a challenge.

Populations

It is likely that ABBs from Camp Gruber and Fort Chaffee are components of functionally the same biological population, given the distance between the two sites [53 miles (85 km)], and the distances ABBs observed moving [up to 6.2 miles (10 km) over a 6-night period], (Service 1991).

SPECIES/CRITICAL HABITAT DESCRIPTION

The ABB was proposed for federal-listing in October of 1988 (53 FR 39617) and was designated as endangered on July 13, 1989 (54 FR 29652) and retains this status. Critical habitat has not been designated for the ABB. The Final Recovery Plan was signed on September 27, 1991. A 5-year review of the ABB's listing status was completed by the Service on June 16, 2008. The review found that, based on the information available, the ABB remains endangered throughout its current range.

The ABB is an annual species, nocturnal, active in the summer months and inactive during the winter months. They bury themselves in the soil for the duration of the winter. They typically only reproduce once in their lifetime. The young of the year overwinter as adults and comprise the breeding population the following summer (Kozol 1990b). Both adults and larvae are dependent on carrion for food and reproduction. They must compete with other invertebrate species, as well as vertebrate species, for carrion. Even though ABBs are considered feeding habitat generalist they have still disappeared from over 90 percent of their historic range. Habitat loss, alteration, and fragmentation, which creates edge habitat, leads to a reduced carrion prey base and an increase in vertebrate scavengers; these factors contribute to the decline of the ABB (Service 1991).

Description

The ABB is the largest silphid in North America, reaching 1 to 1.8 inches (27-45 mm, Wilson 1971, Anderson 1982, Backlund and Marrone 1997). Pronotal width is highly correlated with weight (Kozol et al. 1988). Size (pronotal width) of ABBs ranged from 0.344 – 0.500 inches (7.83 – 12.71 mm) in a laboratory study and 0.314 – 0.497 inches (7.98 – 12.63 mm) at Block Island. They are black with orange-red markings and are sexually monomorphic. The hardened elytra are smooth, shiny black, and each elytron has two scallop shaped orange-red markings. The pronotum (hard back plate of the front portion of the thorax of insects) over the mid-section between the head and wings, is circular in shape with flattened margins and a raised central portion. The most diagnostic feature of the ABB is the large orange-red marking on the raised portion of the pronotum, a feature shared with no other members of the genus in North America (Service 1991). The ABB also has orange-red frons and a single orange-red marking on the clypeus, which is located on the head just above the mandibles. Antennae are large, with notable orange club-shaped tips.

Gender can be determined visually by examining the clypeus. Males have a large, rectangular, red marking and females have a smaller, triangular, red marking. Ageing is also determined by visual examination. The markings of teneral ABBs are brighter and appear more uniform in color while the exoskeleton is softer and in general more translucent. The pronotum of a mature, second season adult tends to be darker than the markings on its elytra, with the former appearing dark orange to red and the latter appearing orange. The senescent ABB has pale elytral markings, seemingly lacking pigment compared to other age classes. Also, senescent ABBs are more scarred, often with pieces missing from the margin of the pronotum or elytra, have cracks in the exoskeleton, and/or are missing appendages (e.g., tarsi, legs, or antennae).

LIFE HISTORY

The life history of the ABB is similar to that of other *Nicrophorus* species (Kozol et al. 1988; Pukowski 1933; Scott and Traniello 1987; Wilson and Fudge 1984).

Winter Inactive Period

During the winter months, when the nighttime ambient temperature is consistently below 60°F (15.5°C), ABBs bury themselves into the soil and become inactive (Service 1991). In Oklahoma, this typically occurs in late September and lasts until mid-May, approximately 8 months. However, the length of the inactive period can fluctuate depending on temperature. Recent studies indicate that ABBs bury to depths ranging from 0 to 6 inches (0 to 20 cm), with an average depth of 2.4 inches (6 cm, Schnell et al. 2007). Habitat structure (i.e., woodland vs. grassland) does not appear to be an influencing factor.

Preliminary data suggest that over-wintering results in significant mortality (Bedick et al. 1999). However, winter mortality has only recently begun to be investigated. Winter mortality may range from 25 percent to about 70 percent depending on year, location, and availability of carrion in the fall (Schnell et al 2007; Raithel 1996-2002 unpubl. data). Overwintering ABBs with access to a whole vertebrate carcass in the fall had a survival rate of 77 percent versus a 45 percent survival rate for those ABBs not provisioned with a carcasses.

Summer Active Period

The ABB is a nocturnal species, active in the summer months, emerging from their winter inactive period around mid-May. Nightly activity is most predominant from 2 to 4 hours after sunset, with no captures recorded immediately after dawn (Walker and Hoback 2007, Bedick et al. 1999). During the daytime, ABBs are believed to bury under the vegetation litter. The ABB begin rearing broods soon after emergence from over-wintering. During late May and early June ABBs secure a mate and carcass for reproduction. The reproductive process takes approximately 48-69 days.

Kozol et al. (1994) on Block Island, found ABBs were caught only on nights where the temperature was above 59°F (15°C), but were captured when the temperature was as low as 60°F. In Nebraska, Bedick et al. (1999) found that ABB activity was highest when temperatures were between 59°F (15°C) and 68°F (20°C). ABB activity exhibited a weakly negative relationship with temperature. Other *Nicrophorus* species were captured at 55°F (12.7°C), but activity was reduced when temperatures were below 59°F (15°C). In Oklahoma, ABBs are typically active from mid-May to late-September when nighttime ambient temperatures are consistently above 60°F. In Nebraska, ABBs become active in mid-May (Bedick et al. 1999). Peyton (1996) captured ABBs on May 20 in Nebraska. Weather, such as rain and strong winds, result in reduced ABB activity (Bedick et al. 1999). However, on Block Island, Rhode Island, *Nicrophorus* were trapped repeatedly and successfully on both rainy and windy nights provided the temperature was above 59°F (15°C, Kozol et al. 1988). The ABB may delay nocturnal activity when temperatures are very warm, greater than 75°F (24°C).

Much of the long-term information concerning the life history of the ABB has come from studies at Fort Chaffee in Arkansas, Camp Gruber in Oklahoma, and Block Island, Rhode Island. Block

Island has a relatively stable land use pattern; however, the insular condition of the population, lack of predators, and supplemental carrion provision does not lend itself to comparability to inland populations. While the land use at Fort Chaffee, Arkansas; and Camp Gruber, Oklahoma differs, each installation maintains a relatively consistent land use pattern of its own through time. However, Schnell et al. (1997-2003) and Schnell et al. (1997-2005) reported the number of ABBs captured and the location of high density ABB concentrations varies annually at each site. This observation indicates ABBs are annually cyclic, where there may be high numbers and abundance in one year, followed by a decline in numbers the succeeding year. In addition, each year they reported that areas of high concentration appeared to shift annually throughout the sites. Further, the ABB is an annual species (living for only one year) and the following year's numbers are dependent upon the reproductive success of the previous year.

Capture rates for ABBs are highest from mid-June to mid-July and again in mid-August (Kozol et al. 1988, Bedick et al. 2004, Service 1991) with a decrease in pitfall captures in late July (Kozol et al. 1988). The Service (1991) reported that during late July ABBs were easy to attract to carrion bait but were difficult to capture in pitfall traps.

False negatives are possible outcomes of ABB surveys. Standard transects on Camp Gruber that resulted in ABB captures in one year failed to capture ABBs in another year. Surveys conducted in a given area have resulted in ABB captures during one survey effort but surveys conducted in the same given area within the same active season have resulted in negative ABB captures. During a 10 – 12 night period in the summer, no ABBs were recaptured after 6 nights. This indicates a relatively rapid turnover rate in the trappable ABB population due to factors such as natural mortality, dispersal, and burrowing underground and attending carrion/broods (Creighton and Schnell 1998).

Movement. Nightly movement of ABBs ranges from 0.101 to 1.03 miles (0.16 – 1.66 km). Creighton and Schnell (1998) conducted a study on movement patterns of ABBs at Camp Gruber and Fort Chaffee in 1992 and 1993. They recaptured 68 ABBs over a 12-night period, of those 68, 23 (29.5percent) were recaptured at a site different than the original site of capture. The mean distance moved of the 23 recaptured ABBs over the 12-night sampling period was 1.21 miles (1.95 km) for each ABB [0.101 miles (0.16 km) per night per ABB]. The minimum and maximum distance moved by an individual recaptured ABB was 0.16 mile (0.25 km) in 1 night and 4.3 miles (6.5 km) in 5 nights [0.8 miles (1.29 km) per night], respectively. Six ABBs were recaptured two or three times. The mean movement for these six ABBs was 6.2 miles (10 km) over 6 nights [1.03 miles (1.66 km) per night] over the entire sampling period. The maximum distance moved by one of these six was 0.76 mile (1.23 km) in one night.

Bedick et al (2004) reported average nightly movements of 0.62 mile (1.0 km) with 85 percent of recaptures moving distances of 0.31 miles per night. Schnell et al. (1997-2003) annually determined the average nightly movements of the ABB to be 0.62 miles (1.0 km), using marked individuals over a 9-year period at Camp Gruber. The smallest average nightly movement for any given active season over that same period was 0.52 miles (0.84 km). Schnell et al. (1997-2006) reported a one day movement of 2.6 miles (4.25 km); previously the greatest distance moved was 1.78 miles (239 km, Creighton and Schnell 1998). While this data could be interpreted to imply that an ABB could move 95 miles [153 km, 0.62 (mean nightly movement) times 154 days (May 20 – September 20)] during the active season, the Service does not believe this is an accurate interpretation. Mark and recapture studies at Camp Gruber and Fort Chaffee have yet to find any ABBs that have moved between these installations, a distance of about 54 miles (87 km, Schnell et al. 1997-2003, and Schnell et al. 1997-2005). Even if ABBs moved such long distances, the Service assumes it is unlikely ABBs move in such a consistently linear direction. Considering the ABB's mobility, small size, recorded movement distances, and distance from which they can detect carrion, the Service considers presence/absence surveys to be conservatively effective only over a distance of 5 miles.

Feeding

When not involved with brood rearing, carrion selection by adults for food sources can include an array of available carrion species and size (Trumbo 1992), as well as capture and consumption of live insects. *Nicrophorus* species are capable of finding a carcass between one and 48 hours after death at a distance up to 2 miles (3.22 km, Ratcliffe 1996). Success in finding carrion depends upon many factors including availability of optimal habitats for small vertebrates (Lomolino and Creighton 1996), density of competing invertebrate and vertebrate scavengers, individual searching ability, reproductive condition, and temperature (Ratcliffe 1996). No significant difference was found in the ABBs preference for avian verses mammalian carcasses (Kozol et al. 1988). At Fort Chaffee, Holloway and Schnell (1997) found that ABBs numbers were higher in areas with high densities of small mammals.

Habitat

Feeding Habitat. ABBs are considered feeding habitat generalists and have been successfully live-trapped in several vegetation types including native grasslands, grazed pasture, riparian zones, coniferous forests, mature forest, and oak-hickory forest, as well as a variety of various soil types (Creighton et al. 1993; Lomolino and Creighton 1996; Lomolino et al. 1995; Service 1991). Ecosystems supporting ABB populations are diverse and include primary forest, scrub forest, forest edge, grassland prairie, riparian areas, mountain slopes, and maritime scrub communities (Ratcliffe 1996; Service 1991). The ABB readily moves between differing habitats (Creighton and Schnell 1998, Lomolino et al. 1995).

Walker (1957) captured nine ABBs in a deciduous forest located on the floodplain of a small creek in Tennessee. The site was described as being "park-like" with little undergrowth. This is not unlike the understory conditions found in Oklahoma upland forests. Our bottomland sites, by contrast, tended to have fairly dense undergrowth of small trees and shrubs. Studies by Creighton et al. (1993) at the Cherokee Wildlife Management Area in eastern Oklahoma found relatively more ABBs in oak-hickory forest than grasslands or bottomland forests.

Lomonlino et al. (1995) examined the niche breadth of *Nicrophorus* species at Fort Chaffe and Camp Gruber. Habitat was evaluated in terms of forest development and shrub cover. They found the niche breadth of ABBs ranged from 0.844-0.925, at Fort Chaffe and Camp Gruber, respectively. Although not as high as the ABB, *N. tomentosus* exhibited a high niche breadth of 0.903. In comparison, *N. marginatus*, and *N. orbicollis*, exhibited 0.402, and 0.512-0.707, respectively (*N. orbicollis* was found at both sites). They did not find significant differences in habitat affinities between ABB sexes during this study.

Lomolino and Creighton (1996) evaluated niche breadth of *Nicrophorus* species at east central and southeast Oklahoma (regional level) and at the Tiak Ranger District (local level) of the Ouachita National Forest in southeast Oklahoma. At the regional level, they found ABBs in sites characterized with moderate to well-developed forest with moderate to deep soils and an understory with moderate cover of small shrubs. They also found that *N. tomentosus* has the largest niche breadth, 0.89, followed by the ABB, 0.78. However, this may be a result of *N. tomemtosus* having the tendency to bury carcasses just beneath the litter, but not under the soil. The niche breadth for *N. marginatus*, *N. orbicollis*, and *N. pustulatus* was 0.36, 0.71, and 0.53, respectively.

In contrast to the results of the regional study, ABBs at the Tiak Ranger District had the most restrictive niche breadth, at 0.53, whereas *N. tomentosus* and *N. orbicollis* were 0.80 and 0.84. However, the local and regional studies evaluated different habitat types. The local Tiak District study analyzed- mature forests, second-growth forests, and clearcuts. Results from this study indicated that ABBs avoided clear-cuts and preferred mature forests. The results of this study provide insight into underlying mechanisms of how deforestation, or fragmentation in general, could contribute to the decline of this species. Interpretation of these study results is limited because baited pitfall traps were utilized. This study may only illustrate where ABBs feed but not necessarily where they will be able to successfully reproduce. The ABB likely will not be able to reproduce successfully in such a broad range of habitat conditions.

Similarly, Kozol et al. (1988) reported that *N. americanus* is broadly distributed across available habitats on Block Island, Rhode Island (shrub thickets to grazed fields). The apparent generalist nature of *N. americanus* on Block Island, however, may be an artifact of this insular environment (Crowell 1983). Because of the low diversity of predators and competitors on islands, insular populations often exhibit ecological release, occurring in a broad variety of habitats considered atypical for populations on the mainland (Crowell 1983, Grant 1971, Case 1975, Cox and Ricklefs 1977, Lomolino 1984).

The oak-hickory habitats preferred by ABBs in Oklahoma contrast sharply with the type of habitat in which they are found in Rhode Island. On Block Island, *N. americanus* is most common in areas with deep soil and light agricultural activity. These habitats are not natural, however. The natural vegetation of Block Island has been altered during the past 200 years from hardwood forest to post-agricultural maritime scrub, mowed fields, and grazed pastures (Service 1991). Holloway and Schnell (1997), utilizing baited pitfall traps, found significant correlation between the number of ABBs captured and the biomass of mammals (0-200 g), and mammals and birds at Fort Chaffee.

The geographic distribution of ABBs and the biomass of mammals exhibited notable concordance, except for the far northwest section of Fort Chaffee where ABB numbers were lower. This lower number of ABBs could be a result of this section of Fort Chaffee being a peninsula extending from the main portion of the installation, thereby having increased edge effect.

Soil conditions for suitable ABB habitat must be conducive to excavation by ABBs (Anderson 1982; Lomolino and Creighton 1996). In Arkansas and Oklahoma, ABBs are found within a mixture of vegetation types from oak-hickory and coniferous forests on lowlands, slopes, and ridgetops to deciduous riparian corridors and pasturelands in the valleys (Service 1991; Creighton et al. 1993). Soils in the vicinity of captures are all well drained and include sandy loam and silt loam, with a clay component noted at most sites. Level topography and a well formed detritus layer at the ground surface are common (Service 1991). In 1996 more than 300 specimens were captured in Nebraska habitats consisting of grassland prairie, forest edge, and scrubland (Ratcliffe 1996). These surveys have found certain soil types such as very xeric (dry), saturated, or loose, sandy soils to be unsuitable for carcass burial and thus are unlikely habitats.

Reproductive Habitat. While studies indicate that the ABB is a habitat generalist in terms of feeding, it is likely more stenotopic when selecting burial sites for breeding. Anderson (1982) postulated that paired ABBs placed on carcasses will be more reproductively successful in forested habitats due to the rich, loose soils conducive to digging. Lomolino and Creighton (1996) found reproductive success to be higher in forest verses grassland habitat, because more carcasses were buried in the forested habitat than the grassland. They theorize that carcasses are more difficult to secure in grassland due to the near absence of a litter layer and that they are more difficult to bury due to the tendency of grassland soils to be more compact than those in forest. However, of the carcasses buried, habitat characteristics did not significantly influence brood size. Holloway and Schnell (1997) found significant correlations between the numbers of ABBs caught in traps and the biomass of mammals and birds, irrespective of the predominant vegetation.

Reproduction

Reproductive activity commences in mid-May and is completed in mid-August in Oklahoma and Arkansas. Parental care in this genus is elaborate and unique because both parents participate in the rearing of young (Bartlett 1987, Fetherston et al. 1990, Scott 1990, and Trumbo 1990), with care by at least one parent, usually the female, being critical for larval survival (Ratcliffe 1996). This is a rare and highly developed behavior in insects, previously known only among bees, ants, wasps, termites, and a few scarab beetle species. In Nebraska, Bedick et al (1999) found that ABBs are univoltine. However, in a laboratory setting, Lomonlino and Creighton (1996) found that five of eight ABB pairs succeeded in producing a second brood. In Nebraska, breeding has been recorded as beginning on June 4, using 60 days as the minimum development time.

Immediately upon emergence from their inactive period, ABBs begin searching for a proper carcass for reproduction. American burying beetles are able to locate carcasses using chemoreceptors on their antennae. Once a carcass has been found, interspecific as well as intraspecific competition occurs until usually only a single dominant male and female burying beetle remain (Scott and Traniello 1989). Bedick et al. (1999) commonly found *Nicrophorus* species with multiple appendages missing. Kozol (1991) reported that the ABB typically out-competes other *Nicrophorus* species as a result of its larger size. However, they do not evaluate the competition between the ABB and *N. marginatus*, which is diurnal (Bedick et al. 1999).

Male and female ABBs typically cooperatively bury a carcass, but individuals of either sex are capable of burying a carcass alone (Kozol et al. 1988). Once underground, both parents shave off the fur or feathers, roll the carcass into a ball, and treat it with anal and oral secretions that retard the growth of mold and bacteria. The female lays eggs in the soil near the carcass. Brood sizes for ABBs can sometimes exceed 35 larvae, but 12-18 is more typical (Kozol 1990a). Altricial, lightly sclerotized larvae hatch in about 12-14 days and the parents move the altricial, first instar larvae to the carcass. The developing larvae solicit feeding by stroking the mandibles of the parents. Both male and female parents regurgitated meat to the larvae. The larvae are soon capable of feeding directly from the carcass. In about 10-14 days large, third instar larvae burrow a short distance from the now-diminished carcass and form pupation cells. One or both of the parents may remain with the pupae for several days and at least one parent, usually the female, may remain with the pupae until they pupate (Kozol 1991). So, for approximately 22-28 days, adult ABBs are present with their brood. New adult's eclose in about 26-51 days. The reproductive process from carcass burial to eclosure is about 48 to 79 days (Ratcliffe 1996, Kozol 1991, Bedick et al. 1999). Females are reproductively capable immediately upon eclosure. The young of the year overwinter as adults, comprising the breeding population the following summer (Kozol 1990b).

While the ABB has life history requirements similar to other carrion beetles, it is the largest *Nicrophorus* in North America and requires a larger carrion item to realize its maximum reproductive potential (i.e., to raise a maximum number of offspring) than the other *Nicrophorus* (Service 1991, Kozol et al. 1988, Trumbo 1992). Preferred carrion sources are dead birds and mammals weighing from 1.7-10.5 oz (48.19 – 297.67 g), with an optimum weight of 3.5-7.0 oz (99.22 – 198.45 g, Service 1991). Other *Nicrophorus* species are able to utilize much smaller carrion, ranging from 0.11 - 0.18 oz (3-5 g, Trumbo 1992). Kozol et al. (1988) found that to maximize fecundity a carcass of 3.53 – 7.05 oz (100-200 g) was preferred by ABBs. Kozol et al. (1988) found on Block Island, that *N. orbicollis* primarily buried carcasses ranging from 0.71 – 0.88 oz (20-25 g), and *N. marginatus* and ABBs ranged from 2.82 – 3.52 oz (80-100 g). However, the ABB was recorded as burying carcasses between 7.05 – 10.58 oz (200-300 g).

Kozol et al. (1988) demonstrated that there is a positive relationship between carcass weight (100-200 grams is ideal) and brood weight. In addition, they found a significant positive correlation between the number of tenerals eclosed and carcass weight. Trumbo and Wilson (1993) found this true for other *Nicrophorus* as well. Lomonlino and Creighton (1996) found no relationship between carcass size and number of young raised in ABBs, but they speculated this may have been due to poor egg or larva survivorship in some broods. No significant correlation was found between carcass weight and mean weight of tenerals or mean pronotal width of tenerals (Kozol et al. 1988). The significant correlation between the number of adult's eclosed per brood and their average weight suggest that ABB individuals rearing broods may make a tradeoff between a large number of small offspring or a small number of large offspring. The outcome of this tradeoff may depend on carcass size, prior reproductive history of the parents, and possibly a prediction of future reproductive opportunities for the offspring.

Conservation

Reintroduction. Establishing new populations with introductions may be made more difficult because of the dilution effects of dispersal. Individuals released at a site may move out of the area, making it difficult to establish a stable population. The probability of successful reintroductions of ABBs can be enhanced by sequestering released pairs of adults on carrion (Amaral et al. 1997). Furthermore, dispersal of teneral adults (progeny of released animals) can be lowered by providing carrion at or near the release site at the time when new adults are likely to emerge (48-65 days after carcass burial; Kozol et al. 1988).

The first reintroduction of the American burying beetle occurred on Penikese Island, Massachusetts from 1990-1993 using captive-raised and wild beetles translocated from Block Island. However, this population became extirpated 9 years after the last release of ABBs (Amaral and Mostello 2007). A second long-term reintroduction effort on Nantucket Island, Massachusetts, is still being evaluated and has not yet reached either the population size or persistence target. In Ohio, a multi-year reintroduction effort has been implemented. However, to date no ABBs have been captured in post-release years. Reintroduction efforts have yet to demonstrate that an extirpated population can become successfully re-established.

THREATS

Data show that species in the family Silphidae are generally widely distributed and occur in many habitat types (Peck and Kaulbars 1987). Even though ABBs are considered feeding habitat generalists they still have disappeared from over 90 percent of their historic range. The Recovery Plan identifies the following issues as potential threats to the ABB: disease/pathogens, DDT, direct habitat loss and alteration, interspecific competition, increase in competition for prey, increase in edge habitat, decrease in abundance of prey, loss of genetic diversity in isolated populations, and agricultural and grazing practices. None of these theories alone adequately explain why the ABB declined while congeneric species are still relatively common rangewide [there are eight sympatric congeners which are not in peril (Sikes and Raithel 2002]. There is little doubt that habitat loss and alteration affect this species at local or even regional levels, and could account for the extirpation of populations once they become isolated from others (Kozol 1995, Ratcliffe 1996, Amaral et al. 1997, Bedick et al. 1999). The prevailing theory regarding the ABBs' decline is habitat fragmentation (Service 1991) which reduced the carrion prey base and increased the vertebrate scavenger competition for this prey (Kozol 1995, Ratcliffe 1996, Amaral et al. 1997, Bedick et al. 1999) due to its relatively large size and specialized breeding behavior (Creighton et al. 2007).

Habitat is the place in which an organism lives, characterized by its physical features or by the dominant plant types (Oxford Dictionary of Biology 2000). Fragmentation is the breakup of extensive habitats into small, isolated patches that are too limited to maintain their species stocks into the indefinite future and reduction of the total amount of habitat available (MacArthur and Wilson 1967, Williamson 1981). There is not a size limitation of disturbed areas which constitute fragmentation. The limiting factor of fragmentation is not only the loss of habitat but the inability to move between undisturbed areas, the quality of the disturbed area species move around in and through, the spatial structure of the undisturbed habitat and disturbed areas, and the ratio of edge habitat created from fragmentation to the amount of contiguous undisturbed area. Fragmentation of natural habitat that historically supported high densities of indigenous (native) species (made more severe by direct taking, ca. 1900, of birds and other vertebrates) may have been a contributing factor in the decline of ABBs.

Initial fragmentation may have minimal impact on vegetation, and species composition and abundance patterns. But as gaps increase in size and quantity, these gaps become the dominant habitat type in a landscape. Ecosystem functions are more likely to be disrupted at finer scales of fragmentation, although the organisms affected are smaller and the overall process is less noticeable to human observers. Probably some of the strongest effects of fragmentation on ecological processes will turn out to involve the invertebrate community (Didham et al. 1996). Invertebrates are critically important in decomposition, nutrient cycling, disturbance regimes, and other natural processes in ecosystems, and they appear to be quite sensitive to disruption of microclimate and other effects of fragmentation. Increased use of land for urbanization and commercial agriculture and forestry has had a demonstrative negative impact on numerous insect species (Pyle et al. 1981).

Pipelines, roads, well pads, utility corridors, etc., are all actions that result in fragmentation of habitat type creating edge habitat.

Direct Habitat Loss and Alteration

Anderson (1982) attributed the decline of *N. americanus* to the coincident pattern of deforestation in North America resulting in habitat loss and fragmentation. He based this conclusion on the assumption that *N. americanus* is similar in habitat requirements to *N. germanicus* of Europe and *N. concolor* of Japan and China. Each of these species is the largest member of their guild and requires relatively large carcasses [1.76 to 10.58 oz (50 to 300 g) Kozol et al. 1988]. Anderson (1982) held that the dependence on larger carcasses for breeding restricts these species to mature forest with open understories and deep, loose soils.

Creighton et al. (2007) reported similar findings in the Tiak District of the Ouachita National Forest in southeastern Oklahoma. The habitat is dominated by mature oak-pine forest with moderate undergrowth and sandy soil. They found a significant decline in the densities of ABBs in seed tree timber harvested areas. In addition, *N. orbicollis* and *N. tomentosus* were affected negatively by timber harvesting. Bedick et al. (1999) also found few ABBs in disturbed and fragmented habitats. Lomolino and Creighton (1996) evaluated habitat parameters at a regional and local level. At a local scale, the Tiak Ranger District, *Nicrophorus* exhibited highly significant avoidance of clearcuts. It is important to recognize that although a feeding generalist, ABBs avoided utilizing clear cuts even for feeding. At a regional level, encompassing east-central and southeastern Oklahoma, all *Nicrophorus* species exhibited significant habitat selectivity (i.e., their niche breadths were significantly less than the maximum value of 1.0), and ABBs were found in sites characterized with moderate to well-developed forest with moderate to deep soils and an understory with moderate cover of small shrubs. The ABB exhibited the most restrictive niche breadth, at 0.53, whereas *N. tomentosus* and *N. orbicollis* were 0.80 and 0.84. The local and regional studies evaluated different habitat types. The local study evaluated mature forest, second-growth forest, and clear-cut; whereas the regional studies evaluated forest development, soil depth, and understory woody cover. Also during this study, reproductive success was found to be higher in forest verses grasslands. Again as stated above Kozol et al. (1988) reported that *N. americanus* is broadly distributed across available habitats on Block Island, Rhode Island (shrub thickets to grazed fields). The apparent generalist nature of *N. americanus* on Block Island, however, may be an artifact of this insular environment (Crowell 1983).

Conversely, studies by Creighton et al. (1993) suggested that ABBs in Oklahoma occur in both upland forests and grassland, and they tend to avoid bottomland forests, but preference was shown for upland forest over grasslands. Holloway and Schnell (1997) found significant correlations between the numbers of ABBs caught in traps and the biomass of mammals and birds, irrespective of the predominant vegetation.

Dispersal is more likely to maintain metapopulations in naturally patchy landscapes than in formerly continuous landscapes fragmented by human activity (den Boer 1970). Natural patchy landscapes have less contrast between adjacent patches, whereas anthropogenic fragmentation creates intense, sudden contrast between patches. This edge habitat is a zone where the light, wind, microclimate, and moisture are altered. The effects from these changes extend into different forest types at distances of 450, 656 to 1,640 feet. Climate edge effects may explain why dung and carrion beetle communities in 2.5 and 25 acre forest fragments in Brazil contain fewer species, sparser populations, and smaller beetles than do comparable areas within intact forest (Klein 1989). The drier conditions in small fragments, which are largely edge habitat, may lead to increased fatal desiccation of beetle larvae in the soil.

There is evidence to support a direct correlation between edge, or fragment size, and vertebrate scavenger pressure, with much of this work involving nesting bird populations (Paton 1994; Yahner and Mahan 1996; Suarez et al. 1997). Trumbo and Bloch (2000) found that *Nicrophorus* species had significantly greater success in larger woodland plots and attributed this in part to lower vertebrate scavenger success in those areas. Sikes (1996), working with *N. nigrita*, found that most transects laid more than 328 feet from a trail or road had 10 percent or fewer carcasses taken by vertebrates, whereas transects near trails or roads had an average of 85 percent of the carcasses taken by vertebrate scavengers. Schnell et al. (1997-2005) found higher numbers and abundances of ABBs within Fort Chaffe, Arkansas and Camp Gruber, Oklahoma boundaries than outside.

Although, some mobile species can integrate into a number of habitat patches this does not appear to be the case with the ABB. Schnell et al. (1997-2006) found that ABBs avoided clear-cut areas in southeast Oklahoma. Such fragmentation is comparable to pipelines, roads, well pads, utility corridors, commercial and residential development and quarries. The effect of competition, which should be strongly linked to habitat conditions, is likely to be a scale-dependent phenomenon. Tillman et al. (1994) suggest that even moderate levels of habitat destruction and fragmentation can 'cause time delayed, but deterministic extinction' of 'dominant competitors in remnant patches'.

The eclectic occurrences and extinction vulnerability of ABBs is likely due to the species having specialized habitat or resource requirements and carrion being a finite resource widely scattered in space and time (Karr 1982, Pimm et al., 1988, Peck and Kaulbars 1987). Data available for the ABB on Block Island supports the contention that the primary mechanism for the species' rangewide decline lies in its dependence on carrion of a larger size class relative to that utilized by all other North American *Nicrophorus* species, and that the optimum-sized carrion resource base has been reduced throughout the species' range over time (Service 1991). Further, when resources fluctuate seasonally or annually, species dependent on those resources fluctuate. This population variability predisposes species to extinction. The higher level of fluctuation the greater the chance of extinction. Habitat fragmentation affects these types of species by reducing the number of sites that contain critical resources, and by isolating suitable sites and making them harder to find.

Since the middle of the 19^{th} century, certain faunal species in the favored weight range for ABBs have either been eliminated from North America or significantly reduced over their historic range (Service 1991), including , the passenger pigeon *Ectopistes migratorius,* greater prairie chicken *Tympanchus cupido* and wild turkey *Meleagris gallopavo*. The passenger pigeon was estimated at one time to have been the most common bird in the world, numbering 3 to 5 billion (Ellsworth and McComb 2003). There were once as many passenger pigeons within the approximate historic range of the ABB as there are numbers of birds of all species overwintering in the U.S. today. Wild turkeys, for example, occurred throughout the range of the ABB, and until recently, were extirpated from much of their former range. Black-tailed prairie dogs *Cynomys ludovicianus* which occur in the northern portion of the ABB's range have drastically declined (Miller et al. 1990) and such dense populations of mammals also may have supported ABBs.

Simultaneously, the removal of top-level carnivores such as the grey wolf *Canis lupis* and eastern cougar *Puma concolor*, as well as land use changes that fragmented native forest and grasslands, creating more edge habitats, resulted in meso-carnivores becoming abundance. These mid-sized carnivores prey on small mammals and birds and directly compete with beetles by scavenging for carrion. Fragmentation of habitats may increase species richness, but the species composition results in the decrease of indigenous species and changes to species that thrive in areas disturbed by humans such as: American crow *Corvus brachyrhynchos*, raccoon *Procyon lotor*, red fox *Vulpus fulva*, opossum *Didelphis virginiana*, striped skunk *Mephitis mephitis*, rats *Neotoma spp.* and *Sigmodon spp.*, squirrels *Sciuridae spp.*, coyotes *Canis latrans,* feral cats, and other opportunistic predators (Wilcove et al. 1986). In this way, historically large expanses of natural habitat that once supported high densities of indigenous species are now habitat fragments that not only support fewer or lower densities of indigenous species that supported ABB populations, but also facilitated increased competition for limited carrion resources among the "new" predator/scavenger community. A number of these species, especially the raccoon and striped skunk, have undergone dramatic population increases over the last century (Garrott et al. 1993), and the coyote and opossum have expanded their range. These scavengers may extend hundreds of feet from edges into forest in eastern North America. Matthews (1995) experimentally placed 64 carcasses in various habitats in Oklahoma where ABBs and *N. orbicollis* had been previously documented, then tracked the organisms that scavenged them. Of the carcasses 83 percent were claimed by ants, flies, and vertebrate scavengers; about 11 percent were claimed by *N. orbicollis*, and only one was claimed by ABBs.

Although much of the evidence suggesting the reduction of carrion resources as a primary mechanism of decline is circumstantial, this hypothesis fits the temporal and geographical pattern of the disappearance of ABBs, and is sufficient to explain why ABBs declined while congeneric species did not. ABBs are the largest species of *Nicrophorus* in the New World and require carcasses of 3.5 to 7.0 ounces (99.22 to 198.45 g, Kozol et al. 1988) to maximize its fecundity, whereas all other *Nicrophorus* species can breed abundantly on much smaller carcasses, with the smaller species using carcasses of 0.11 to 0.18 ounces (3.12 to 5.10 g, Trumbo 1992). In a fragmented ecosystem, larger species have been shown to be negatively affected before smaller species, a phenomenon which has been well-documented with carrion and dung beetles in South America (Klein 1989).

Wide-ranging animals, like the ABB, are typically among the species most threatened by habitat fragmentation, in part because small areas fail to provide enough prey, but also because these animals are more likely to be killed by humans or their vehicles (Karr 1982, Pimm et al. 1988, Mladenoff et al. 1994, Noss et al. 1996). Large mobile species that roam over large areas daily must attempt to move through the fragmented habitat. Moving relatively long distances among different habitat types increases the ABB's chance of encountering appropriate-sized carcasses, but also increase the potential for encountering natural and unnatural mortality, such as predation, insecticides, insect traps (e.g., bug zappers), and nocturnal light pollution (Mladenoff et al. 1994, Noss et al. 1996). The probability of individual ABBs being subjected to these types of hazards also increases as areas become more developed (Lomolino and Creighton 1996). A study in southeastern Ontario and Quebec found that several species of small mammals rarely ventured onto road surfaces when the road exceeded 65 feet (19.8 m, Oxley et al. 1974). Studies elsewhere report similar findings. These studies reveal potential indirect effects to the ABB by limiting its food and reproductive resources. These findings may explain, in part, why the highest densities of ABBs are in relatively large military installations with little agricultural, commercial or residential development.

Bedick et al. (1999) found in Nebraska and South Dakota that ABBs were observed in areas with low human population densities, minimal night-time artificial lights, and are primarily used for grazing of beef cattle and some agriculture. In Kansas, much of the area occupied by the ABB is privately owned native grass pasture and scattered woodlands of blackjack oak *Quercus marilandica* (Miller and MacDonald 1997). In Texas, the ABB is has only been found on Camp Maxey and The Nature Conservancy's Lennox Woods in Red River County.

Species Size

For most guilds, larger species tend to feed on larger prey, occupy a greater diversity of habitats, dominate in interference competition, and maintain larger homeranges, but may suffer from exploitative competition from smaller species (Ashmole 1968, Gittleman 1985, Hespenheide 1971, Rosenzweig 1968, Schoener and Gorman 1968, Werner 1974, Wilson 1975, and Zaret 1980). Because larger prey is less abundant than smaller prey (Peters 1983, Brown and Maurer 1987, Damuth 1991, and Lawton 1990), larger guild members require larger home ranges. In addition, larger carcasses are harder to bury than smaller ones (Creighton et al. 2007). While large size alone does not necessarily confer endangerment, within trophic or guilds rarity and extinctions tend to be higher for the larger species (Diamond 1984; Martin and Klein 1984; Vrba 1984; Owen-Smith 1988; and Stevens 1992). At less than 2 grams, the ABB is the largest member of a guild that specializes on rare and unpredictable resources, vertebrate carcasses. In contrast to other guild members the ABB must range over a larger area and a greater diversity of habitats to find suitable carcasses.

Trumbo and Thomas (1998) investigated *Nicrophorus* species composition on several small islands in New England (lacking ABBs) and found that smaller islands were not able to support viable populations of large-bodied *Nicrophorus* species. They suggested that larger species required more carrion resources and were therefore more prone to local extinctions. The extant population of ABBs on Block Island seems to be relatively free of competitive pressures; not only are there unusually large populations of ground-nesting birds, but there are few mammal predators or scavengers and supplemental carrion provisioning is provided annually (Amaral et al. 1997). This hypothesis is among those most well supported by the available evidence. However, more studies on response of silphid communities to habitat fragmentation are needed, especially those that will contrast historic and current habitats, or compare multiple extant sites of ABBs.

Disease/Pathogens

The ABB disappeared from its core range and persists only on the very periphery of its historic range. A pathogen hypothesis readily accounts for such a geographic pattern of decline. Any pathogen that could be transmitted among adult burying beetles, and was non-fatal to congeners of ABBs, will eliminate all contiguous ABB populations, leaving only peripheral isolates untouched. In addition symbiotic mites and nematodes of the ABB could also contribute to the spread of disease. Service (1991) suggested this hypothesis but pointed out that no evidence of a disease or pathogen has been found. However, no known rigid investigation has been conducted to test this hypothesis. Peck and Anderson (1985) determined that ABBs are phenotypical and presumably evolutionary distant from other *Nicrophorus* species in North America. Therefore, ABBs could be physiologically unique and vulnerable to a pathogen to which its congeners are immune. Channel and Lomolino (2000) investigated the geographic pattern of decline in 245 endangered species. Their analysis showed that the remaining populations of many endangered species (98 percent of their sample), including birds, mammals, fish, mollusks, arthropods, and plants, are in the peripheries of their former range. So while this hypothesis cannot be eliminated as a possible reason of decline, such consistent spatial remnant populations of endangered species indicates that other factors are likely the contributors to such declines.

DDT/Pesticide Use

Hoffman et al. (1949) showed, in a controlled study, that DDT spraying eliminated populations of three *Nicrophorus* species (*N. orbicollis*, *N. sayi*, and *N. defodiens*). Kozol (1995) and the Service (1991) concluded that given the apparent timing and pattern of decline exhibited by ABBs, particularly in the Northeast, DDT could not have been responsible for most extirpations, since populations were largely gone a full 25 years before organochlorine compounds were broadly applied as pesticides. In addition, some populations persisted following DDT spraying in Oklahoma, Nebraska, and Missouri, while other unsprayed areas within the ABBs historical range no longer support the species. In the Midwest however, several ABB populations disappeared during or right after the general period from 1940 to 1972, when DDT was actively applied as a pesticide. Although, this hypothesis is rejected as the primary explanation, it remains possible that some ABBs may have been extirpated by DDT use.

Intraspecific and Interspecific Competition

Intrasexual competition occurs until usually only one male and female remain. Size appears to be the most important determinant of success in competition for securing carrion; the largest individuals displace smaller *Nicrophorus* (Kozol et al. 1988). Even after burial of a carcass ABBs have been recorded as commandeering a carcass buried by another *Nicrophorus* species. However, factors other than size might affect the outcome of competition (i.e., temperature or activity patterns). Trumbo (1992) showed that the potential for *Nicrophorus* congener competition for carrion increased with carcass size and Scott et al. (1987) found the same results with carrion-feeding flies. Congener competition extends from the increase in vertebrate scavenger pressure, exacerbated by habitat fragmentation, and a decrease in carrion of the ideal weight size, due to extinction and population declines, the competition between ABBs and sympatric congeners for sub-optimally sized carcasses will be expected to increase.

The ABB's most similar congener is *N. orbicollis*, based on historical geographic range, presumably the ecological tolerances (diel periodicity, breeding season, etc.), and phylogenetic information indicating these species may be each other's closest surviving relatives (Szalanski et al. 2000). Being so similar, they likely are each other's greatest congeneric competitors (Sikes and Raithel 2002). Interspecific competition may affect populations at the local level. Typically, surveys for ABBs result in 10 or more times more *N. orbicollis* than ABBs (Lomolino and Creighton 1996, Amaral et al. 1997, Carlton and Rothwein 1998). Kozol (1989) demonstrated that *N. orbicollis* was about eight times more abundant than ABBs on Block Island, Rhode Island while Walker (1957) collected 19 times more *N. orbicollis* (175) than ABBs (9) in the single trapping array where the latter species was encountered in Tennessee. While the ABB is more successful than *N. orbicollis* in utilizing carcasses greater than 100 g, these data suggest that this congeneric species may pose formidable competitors for the ABB (Sikes and Raithel 2002) and may have actually increased (been "released") in those areas where ABBs disappeared (Service 1991). In addition, *N. marginatus* may be a formidable competitor to ABBs. *N. marginatus* is on average slightly larger and utilizes larger carcasses than *N. orbicollis* and in Nebraska and South Dakota is typically more abundant (Backlund and Marrone 1997 and Bedick et al. 1999). Another, threat to ABB reproductive success is the oviposition by other *Nicrophorus* species near an ABB buried carcass, allowing brood parasitism (Müller et al. 1998, Trumbo 1994). Trumbo (1992) found that mixed *Nicrophorus* broods were more common on larger carcasses.

The imported fire ant *Solenopsis invicta* has become a formidable competitor for carrion and a potential source of mortality for Nicrophorus beetles when they co-occur at a food source (Warriner 2004, Godwin and Minich 2005). Scott et al. (1987) concluded that the inability of *N. carolinus* to successfully bury carrion provided experimentally in Florida was due to interference by imported fire ants. Only 5 of 48 carcasses were successfully exploited by *N. carolinus*, despite pitfall trapping that demonstrated that *N. carolinus* was locally abundant. Collins and Scheffrahn (2005) noted that fire ants may reduce ground-nesting populations of rodents and birds, and in some instances, may completely eliminate ground-nesting species from a given area. Fire ant infestations are not evenly distributed; rather, they tend to be more numerous in open, disturbed habitats (Carlton in litt. 1996). Fire ants now infest all or parts of Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, and Texas (USDA 2003).

Loss of Genetic Diversity in Isolated Populations

Kozol et al. (1994) examined ABB genetic variation within and between the Block Island, Rhode Island and the eastern Oklahoma and western Arkansas population. Both populations have low levels of genetic variation, and most of the variation occurs within a single population. There were no unique diagnostic bands within either population, but they found the Oklahoma/Arkansas population to be somewhat more diverse. This reduced genetic variation is often a result of founder effect, genetic drift, and inbreeding. They suggest that multiple bottleneck events, small population size, and high levels of inbreeding may be factors contributing to the pattern of diversity in ABBs.

Szalanski et al. (2000) expanded on Kozol et al.'s (1995) study and examined ABBs from five populations: Block Island, Rhode Island, Arkansas, South Dakota, Oklahoma, and Nebraska. The authors found little evidence that the five populations have maintained unique genetic variation and no evidence to suggest that these five populations should be treated as separate, genetically independent conservation segments.

ANALYSIS OF THE SPECIES/CRITICAL HABITAT LIKELY TO BE AFFECTED

The ABB may potentially be affected by the implementation of this transmission line and associated facilities. Various types of disturbance associated with typical construction activities can result in impacts to the ABB. Critical habitat as defined by the ESA has not been designated for the ABB; therefore, none will be affected.

ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human induced and natural factors leading to the current status of the species, its habitat, and ecosystem, within the project area. The environmental baseline is a "snapshot" of the status of the ABB at the time this document was prepared.

STATUS OF THE SPECIES WITHIN THE ACTION AREA

During August 2009, ENERCON conducted presence-absence surveys according to USFWS guidelines for the ABB along the proposed ROW. A total of seven ABBs were captured from six transect locations during this survey. However, survey efforts were suspended because of fire ant infestation of the project area.

FACTORS AFFECTING SPECIES ENVIRONMENT WITHIN THE ACTION AREA

Adequately evaluating the effects of this proposed project on the ABB requires that the Service not only consider the impacts from the proposed activities, but must also consider other, separate effects currently ongoing and likely to occur in the foreseeable future that also could have adverse impacts to the ABB within the action area.

Consultation

During fiscal years 2006, 2007, 2008, and 2009 (October 1 to September 30) the Service consulted on approximately 203, 215, 306, and 171 proposed actions, respectively, potentially affecting the ABB in Oklahoma. Project types evaluated included pipelines, roads, quarries, communication towers, residential housing development, bridges, mining, petroleum production, commercial development, recreational development, transmission lines, and water and waste water treatment facilities. Impacts from these activities varied in size and duration, with projects such as quarries being hundreds of acres and having permanent impacts, to water treatment facilities of a few acres with both permanent and temporary impacts.

There are currently four biological opinions with incidental take statements issued and still in effect. One biological opinion authorizes the take of 76 acres within the ABB's range in Osage County for the construction of a botanical preserve. The second biological opinion authorizes take of 35 ABBs per year throughout the Camp Gruber National Guard Installation. The third is a programmatic biological opinion for the Federal Highway Administration (FHWA) within the ABB's range in Oklahoma authorizing take of 5,998.98 acres of ABB habitat. The fourth biological opinion is with the Ouachita National Forest authorizing take of 34,954 acres of ABB habitat within Oklahoma and Arkansas.